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SYSTEMATIC REVIEWS

Cost-effectiveness of food, supplement and environmental interventions to address malnutrition in residential aged care: a systematic review

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Abstract

Background: observational studies have shown that nutritional strategies to manage malnutrition may be cost-effective in aged care; but more robust economic data is needed to support and encourage translation to practice. Therefore, the aim of this systematic review is to compare the cost-effectiveness of implementing nutrition interventions targeting malnutrition in aged care homes versus usual care.
Setting: residential aged care homes.
Methods: systematic literature review of studies published between January 2000 and August 2017 across 10 electronic databases. Cochrane Risk of Bias tool and GRADE were used to evaluate the quality of the studies.
Results: eight included studies (3,098 studies initially screened) reported on 11 intervention groups, evaluating the effect of modifications to dining environment (n = 1), supplements (n = 5) and food-based interventions (n = 5). Interventions had a low cost of implementation (<£2.30/resident/day) and provided clinical improvement for a range of outcomes including weight, nutritional status and dietary intake. Supplements and food-based interventions further demonstrated a low cost per quality adjusted life year or unit of physical function improvement. GRADE assessment revealed the quality of the body of evidence that introducing malnutrition interventions, whether they be environmental, supplements or food-based, are cost-effective in aged care homes was low.
Conclusion: this review suggests supplements and food-based nutrition interventions in the aged care setting are clinically effective, have a low cost of implementation and may be cost-effective at improving clinical outcomes associated with malnutrition. More studies using well-defined frameworks for economic analysis, stronger study designs with improved quality, along with validated malnutrition measures are needed to confirm and increase confidence with these findings.

Keywords: *malnutrition, systematic review, cost, aged care, economic, older people*

Introduction

The financial cost of residential aged care, accommodation and care support for frail and aged residents, is high and increasing [1–3]. While significant resources go towards supporting the health of older residents, outcomes are often suboptimal and associated with malnutrition (undernutrition). Malnutrition is a wasting syndrome which presents most commonly in older adults, and occurs when lean body mass, with or without fat mass, is unintentionally lost due to inadequate bioavailability of energy and protein [4]. Cost-of-illness studies indicate that the annual direct cost of malnutrition in residential aged care ranges from €107 million to €1.7 billion (£98.4 million to £1.56 billion) for the Netherlands and the UK, respectively [5–8].

Higher food budgets (>£4.20 per resident per day) in aged care homes decrease the risk of a resident becoming malnourished by 66% (OR = 0.66 [95% CI: 0.46–0.95], P = 0.023) [9]. Recent research in developed countries demonstrates a downward trend in the amounts spent on

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the food budget in aged care homes [10]. There is also an increase in spending on oral nutrition supplements ('supplements') which is believed to be in response to high malnutrition rates [10]. There is evidence that interventions such as supplements, food-first approaches (prioritising food over supplements) and environmental changes improve clinical outcomes for residents in residential aged care homes [11]. In acute care, these malnutrition interventions are ranked as one of the top strategies to produce health care cost savings by the National Institute for Health and Care Excellence (NICE) [12]. Observational studies have shown that nutritional strategies to manage malnutrition may be cost-effective in the aged care setting; but more robust economic data is needed to support and encourage translation to practice [13–16]. Therefore, the aim of this systematic review is to compare the cost-effectiveness of implementing nutrition interventions (including food fortification, supplements, menu changes and dining environment changes) targeting malnutrition in aged care homes versus no intervention or usual care for older residents.

Methods

A systematic review was planned and reported according to the PRISMA guidelines [17]. The protocol for this review was developed in consultation with topic experts and the search strategy was developed in consultation with an information specialist. The protocol was registered with PROSPERO (http://www.crd.york.ac.uk/PROSPERO) (registration number: CRD42016048175).

Search strategy

Published studies were searched for in the following electronic databases: MEDLINE (PubMed), Cochrane, CINAHL, EMBASE, EBSCO Megafile Complete, Business Source Complete, EconLit, NHS EED and Web of Science from January 2000 to 24 August 2017 Publications predating 1 January 2000 were excluded as health inflation analysis has shown that the health sector prices have grown much faster than inflation, the population, population ageing and the broader economy in the past 15 years [18]. As a result of the documented year-on-year health cost increases, comparison of data prior to the 2000 would be difficult. No language restrictions were used.

The search strategy used keywords and each database's controlled vocabulary (Supplementary Material S1, available at *Age and Ageing* online). The search strategy was complemented by a 'snowball' search which involved pursuing article references of identified studies in addition to electronic citation tracking and brief Google Scholar searches. For this review, nutrition interventions to prevent and/or treat malnutrition in older residents (mean age of sample ≥65 years) dwelling in a residential aged care home were included. Eligibility criteria included studies that had original financial data related to the intervention and/or outcomes. Specifically, studies were included which reported data related to the direct cost, cost-effectiveness and/or cost-benefit of the interventions. Due to differences in economies, studies implemented in developing countries were excluded. Reviews, observational studies, abstracts and conference papers were also excluded from the review.

Selection of studies and data synthesis

After citations were identified from all databases, duplicates were isolated and removed. A two-step screening process was employed. In step 1, two researchers (C.H. and S.M.) scanned the titles and abstracts of studies identified by the search for their potential eligibility. At step 2, full-text articles relating to the inclusion and exclusion criteria were screened by two researchers for eligibility (C.H. and S.M.). Conflicts between the two screening authors were resolved through consensus.

A list of outcomes meaningful to the research aim was developed to identify the relevant effects of the interventions. The primary outcomes were financial and economic data relating to the interventions, including the direct cost of implementing the intervention, the cost of usual care/no intervention, the mean difference between intervention and control, the cost associated with negative patient outcomes related to malnutrition, the cost-savings relating to malnutrition outcomes, the cost per quality adjusted life years (QALYs) and disability adjusted life years (DALYs) associated with the intervention. Secondary outcomes included patient, health and aged care related outcomes associated with malnutrition, including nutrition status, weight change, BMI, energy and/or protein intake, plate wastage, resident satisfaction, staff satisfaction, acute and sub-acute hospital admissions, a change in the level of aged care provided, quality of life, physical function, mental health, self-efficacy, mortality and malnutrition-related complications such as pressure ulcers, poor wound healing, oedema and falls.

Data related to the primary and secondary outcome measures, the study populations and the intervention details were extracted from the published papers into standardised tables by one researcher (C.H.) and checked for accuracy by a second researcher (S.M.).

Review of study strength and quality

Risk of bias of individual studies was assessed using the Cochrane Risk of Bias tool [19] covering six domains of bias: selection, performance, detection, attrition, reporting and other bias (e.g. funding sources, conflicts of interest). The quality of the body of evidence for each type of intervention and outcome was determined using the Grading of Recommendations, Assessment, Development and Evaluation (GRADE) system rated from very low to high quality based on study design, reporting risk of bias, consistency, directness, effect size and precision [20]. The GRADE system is a formal process to rate the quality of scientific evidence in systematic reviews [20].

Results

The search identified 3,098 records (Figure 1). Of these, 87 were considered suitable for full-text review following removal

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of duplicates and initial screening of title/abstracts. From these papers, eight intervention studies met eligibility criteria. Due to inconsistent intervention approaches and methods of reporting cost-related outcomes, data could not be pooled. Interventions ranged in duration from 6 weeks to 6 months with follow-up ranging from 10 weeks to 29 weeks (Table 1). The seven intervention studies were from USA (*n* = 3), Taiwan (*n* = 1), Sweden (*n* = 2), Netherlands (*n* = 1) and UK (*n* = 1) with a total of 774 enroled older adults.

Study quality (risk of bias)

Of the studies reviewed, four were RCTs [21–24], three were non-randomised controlled trials [25–27] and one was a two-armed non-controlled intervention trial [28]. There was a high risk of bias across studies, particularly with lack of, and poor description of, randomisation and blinded allocation, intervention and assessment of outcomes (Figure 2; justifications in Supplementary Material S2, available at *Age and Ageing* online). There was also a high risk of bias regarding outcomes (detection bias), as several studies did not use systematic or validated methods to measure and report financial data. Other bias considered included funding sources and conflicts of interest.

Types of interventions

The eight studies included 11 intervention groups—supplements (*n* = 5), food-based interventions (*n* = 5) and dining environment changes (*n* = 1).

The study incorporating dining environment changes involved the addition of fish aquariums into the dining area of three dementia units, with no other intervention factors.

There were five studies which used ONS, one combined with a high protein-high energy diet and post-hospital discharge telehealth (Table 1). This study was primarily implemented in the hospital setting with post-discharge ONS and fortnightly telehealth consultations from a dietitian to participants, but it is unclear if the telehealth was provided to aged care home-dwelling residents or only those in their own homes [22]. The supplements used had 9.5–12 g of protein and 250–330 kcal; however, two studies did not specify the nutritional content of the ONS used. Timing and dosage of ONS interventions varied from one to two a day, and from weekends only to daily.

Food-based interventions were simple, and included offering additional appetisers and snacks, providing advice to eat high protein-high energy foods, and fortifying usual meals with cream and butter. However, one food-based study implemented three 2-h education sessions to staff promoting nourishing snacks for residents [27] to support the provision of additional foods; and the high protein-high energy intervention received the advice from a dietitian at two time-points over 3 months [28]. The group which received food fortification received an additional 2100 kcal/day; however, no other study reported the additional protein or energy provided.

Financial outcomes by intervention type

Cost data was largely heterogeneous in terms of costs measured, analysis method and style of reporting which

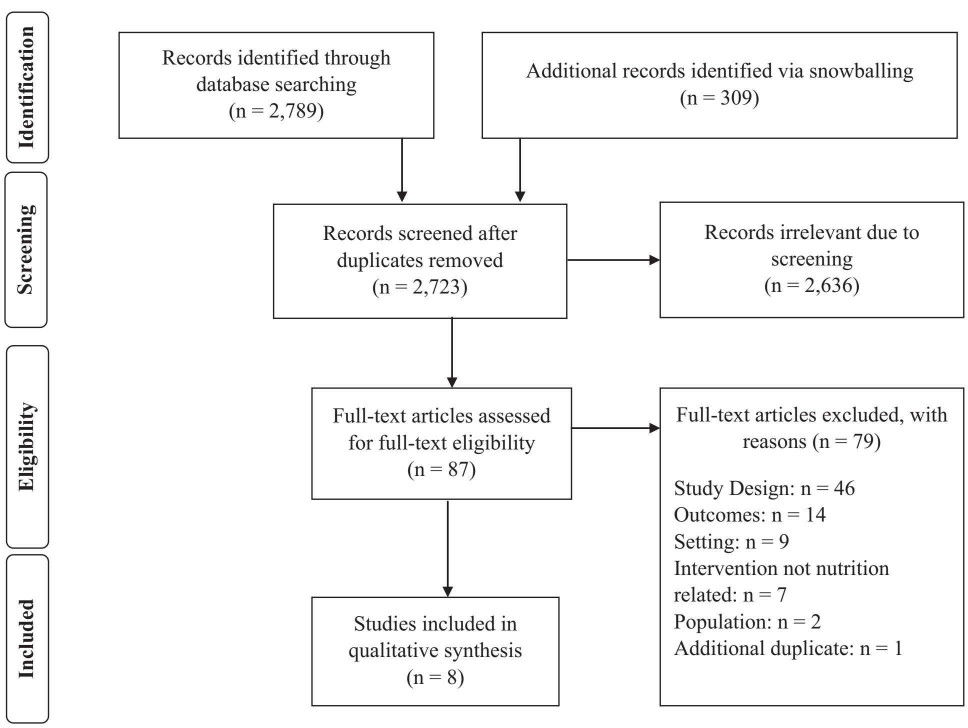

Figure 1. Prisma flow diagram of records identified, screened and included in this systematic literature review.

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Table 1. Study design, characteristics and outcomes of intervention studies with financial outcome data which aim to improve malnutrition in residential aged care

Citation	Setting and population	Study design and economic methods	Intervention and comparator conditions	Summary of findings
Interventions modifying the dining environment				
Edwards and Beck [25]	• USA • Mean age 80.1 years • *N* = 62 participants with Alzheimer's Disease • Females = 61% • *N* = 3 clusters (aged care homes)	• Cluster non-randomised controlled cross-over trial • Intervention: 8 weeks. • Follow-up: 10 weeks • Economic method: basic economic figures. No analysis • Economic cost versus benefit/effect measured: Cost = none reported; benefit/effect = financial benefit (cost saving) reported for one aged care home related to supplement use	• IG: 8 weeks with fish aquarium in the dining room. IG did not cross-over to CG • CG: 2 weeks with scenic ocean picture introduced to dining room followed by a 2-week washout period (no picture and no aquarium) followed then by 8 weeks with aquarium	• IG: food intake increased significantly (27.1% increased compared with baseline; $P < 0.000$). Mean weight increase (1.65lbs; $P < 0.000$) compared with baseline • CG: no significant changes observed in food intake or body weight observed • Between groups: not compared • Economic findings: $11.44 decreased daily cost of ONS in *n* = 1/3 facilities. Currency unclear; assumed to be USD
Interventions providing oral nutritional supplementation				
Lee *et al.* [21]	• Taiwan • Mean age 79-80 ± 8 years • *N* = 92. • Females = 58% • *N* = 1 aged care homes	• Double-blind RCT. • Intervention: minimum of 12–24 weeks depending on needs of participant • Follow-up: 24 weeks + 12 months for mortality • Economic method: cost of intervention/ supplement reported. No analysis • Economic cost versus benefit/effect measured: cost = direct cost of supplement. Benefit/effect = none included in economic analysis	• IG: If BMI < 24 km/m^2 and MNA score <24 were provided a 50 g/day soy protein-based supplement (9.5 g protein, 250 kcal, all essential micronutrients) as a warm drink at AT until MNA or BMI improved to > 24 and > 24 kg/ m^2, respectively + encouragement to consume by staff. • CG: Including non-eligible persons for supplement in IG received normal meals including warm soup at AT.	• Between groups: accounting for group allocation and time, at 24 weeks follow-up, IG participants increased body weight (*β* 1.62 [95% CI: 0.21–3.03], $P < 0.05$), BMI (*β* 0.57 [95% CI: 0.05–1.09], $P < 0.05$), MAC (*β* 0.91 [95% CI: 0.40–141], $P < 0.001$) and CC (*β* 1.00 [95% CI: 0.43–1.80], $P < 0.001$). No improvement in albumin, cholesterol. Mortality not reported • Economic findings: $0.40 (£0.24 per resident per day). Analysis by review authors estimates approximately $2,024 for the cost of supplementation for the entire study period. Assumed dollar is USD
Neelemaat *et al.* [22]	• Netherlands • Mean age 74.6 ± 9.5 years. • *N* = 210. • Female: 55%. • *N* = 0 aged care homes sampled. Sample is a hospitalised population; approximately 10% of which were dwelling in an aged care home	• RCT • Intervention: hospital admission period + 3 months post discharge follow-up • Follow-up: 3 months after hospital discharge • Economic method: CEA and CUA • Economic cost versus benefit/effect measured: Cost = direct costs were supplement costs, telehealth cost, hospital admission costs, specialist visits. Non-direct health costs were included using a diary, e.g complementary medicine, informal care, and other indirect costs were absenteeism paid, unpaid labour. Costs were Dutch standard costs. Effect/benefit: CEA = nutritional status and physical function. CUA: QALY generated by the EQ-D instrument	• IG: in hospital nutrition support: HPHE diet + two ONS (330 kcal; 12 g protein per supplement) + one vitamin/mineral supplement (400IE Vit D3 + 500 mg Ca/day); post-hospital nutrition support: two ONS continued, one vitamin/mineral supplement continued + 6 weeks of fortnightly telehealth (6 sessions total) by dietitian until 3/12 post-hospital discharge • CG: usual care with ONS/other supplements only if physician prescribed. No post-hospital support	• IG: functional limitation change *μ*-0.24 ± S.E.0.15; hospital LOS *μ*13 ± 16.8; QALYs *μ*0.15 ± 0.01; physical activities *μ*0.52 ± 0.17. Significance of change not reported • CG: functional limitation change *μ*-0.47 ± 0.15; hospital LOS *μ*14 ± 12.5; QALYs *μ*0.13 ± S. E.0.01; physical activities *μ*0.42 ± 0.26. Significance of change not reported • Between groups: no significant difference in hospital LOS, QALYs at 3 months follow-up or physical function. IG improved in functional limitations (CG change: *μ*-0.24 ± S.E.0.15 versus IG change *μ*-0.47 ± 0.15; difference −0.72 [95% CI: −1.15 to −0.28; *P*-value not reported]) • Economic findings: overall results (not aged care home specific) £24,798/QALY. £4.111/physical activity scale improvement. €618/functional

Continued

Table 1. Continued

Citation	Setting and population	Study design and economic methods	Intervention and comparator conditions	Summary of findings
				limitation improvement. Probability that intervention is cost-effective for improvement in QALYs and physical activity are low (0.5 and 0.6, respectively). £5,978 (below £18,395 maximum) investment from Netherlands society, 0.95 probability the intervention is cost effective for improvement in functional limitations
Simmons *et al.* [23]	• USA • Mean age 86.9 ± 11.3 years • *N* = 86 • Female = 62% • *N* = 3 aged care homes	• Three-armed RCT • Intervention: 6 weeks • Follow-up: 6 weeks • Economic method: CEA • Economic cost versus benefit/effect measured: cost = additional daily food, fluid or supplement spending and salary for staff time for nutritional care delivery. Benefit/effect = between meal and total daily energy intake	• IG: ONS [not further described] offered twice daily at 10 am and 2 pm. Second intervention arm reported below. Second IG was food based (see below) • CG: no foods or ONS offered, only usual provided food and beverages (not further described)	• IG: compared with baseline, the mean difference of energy intake was −125kcal ($P < 0.05$), Increased energy intake in mid-meals (151 kcal; $P < 0.05$) but this caused an overall ↓ in total energy intake. No significant change in body weight • CG: compared with baseline, the mean difference of energy intake was 5 kcal. No significant change in body weight • Between groups: not compared • Economic findings: mean difference of direct costs of intervention from baseline to 6 weeks were USD$2.10 per resident per day for the supplement group and USD$−0.03 for the control group per resident per day. CEA analysis shows supplement group more likely to result in a decrease in total calories relative to the snack intervention (see below). CEA acceptability curves show snack intervention consistently exceeds supplement intervention for net benefit (e.g. USD$0.04 value of one-unit caloric gain, probability of net benefit is 65% for supplement group and 80% for snack group)
Simmons *et al.* [24]	• USA • Mean age 83.1 ± 11.9 years • *N* = 175 • Female = 81% • *N* = 5 aged care homes	• Three-armed RCT • Intervention: 6 months • Follow-up: 6 months • Economic method: CEA. • Economic cost versus benefit/effect measured: cost = additional daily food, fluid or supplement spending and salary for staff time for nutritional care delivery. Benefits/effects = between meal and total daily energy intake	• IG ONS [not further described] offered twice daily in the morning and afternoon for 5 days per week. Second IG was food based (see below) • CG: no foods or ONS offered, only usual provided food and beverages (not further described)	• IG: average of 1.8 kg weight gain, the mean difference of total energy intake was 253 kcal (95% CI: 109–397). Mid-meal energy intake increased (151 kcal; $P < 0.05$) but this caused an overall decrease in total energy intake • CG: average loss of 0.5 kg body weight in control group • Between groups: not compared • Economic findings: mean difference of direct costs of intervention at 6 months compared with the control group was USD$2.54 per resident per day. Incremental cost-effectiveness ratios 103 kcal/USD$. CEA acceptability curves show

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				supplement intervention consistently exceeds snack intervention (see below) for net benefit (e.g. USD$0.01 value of one-unit caloric gain, probability of net benefit is 57%.)
Elia *et al.* [28], Data also reported in Parsons *et al.* [31]	• UK • Mean age 88.8 ± 8 years • *N* = 104 (incl 57 aged care home residents) • Female = 86%. • *N* = 53 aged care homes	• Two-armed, non-controlled, intervention trial. • Intervention: 12 weeks • Follow-up: 12 weeks • Economic method: CEA • Economic cost versus benefit/effect measured: cost = direct costs of intervention, unit costs of health care utilisation. Benefits/effects = QALYs adjusted for malnutrition and other factors	• IG: ONS (1.5-2.4kCal/ml) aiming to increase intake by at least 600kCal/day and 16 g protein a day. Saw dietitian at baseline and 6 weeks to receive advice relating to ONS. • CG: none. Compared to 12-week baseline observation period	• IG: quality of life (EQ-5D-TTO) decreased (μ change: −0.02) (not tested statistically). Body weight improved (μ change: 1.22 ± 0.45 kg; *P* = 0.010). Energy increased (μ change: 286 kcal) (not tested statistically). QALY gained μ0.1302 ± 0.0084 • CG: N/A • Economic findings: direct cost of intervention: £162.30 per resident • Direct unit cost of health care utilisation: £376 ± 34. Significantly higher than HPHE group (see below) • Cost/QALY: £9857 (ONS group minus HPHE group; actual cost/QALYnot reported for each group)
Interventions providing food-based modifications				
Simmons *et al.* [23]	• As per above	• As per above	• IG: variety of snacks (yoghurt, pudding, fruit, juices) offered twice daily at 10 am and 2 pm • CG: as per above	• IG: compared with baseline, the mean difference of energy intake was 163 kcal (*P* < 0.001) for the snack group. No change in body weight • CG: as per above • Between groups: not compared • Economic findings: mean difference of direct costs of intervention from baseline to 6 weeks were USD$2.06 per resident per day for the snack group, and USD$−0.03 for the control group per resident per day
Simmons *et al.* [24]	• As per above	• As per above	• IG: variety of snacks (yoghurt, pudding, juices, liquid supplements) offered twice daily in the morning and afternoon • CG: as per above	• IG: compared with the control group, the mean difference of total energy intake was 288 kcal (95% CI: 144–432). No change in body weight • CG: as per above • Between groups: not compared • Economic findings: mean difference of direct costs of intervention at 6 months compared with the control group was USD$3.85 per resident per day. Incremental cost-effectiveness ratios 79 kcal/USD$ for the snack group. CEA acceptability curves show supplement intervention consistently exceeds snack intervention for net benefit (e.g. USD$0.01 value

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Table 1. Continued

Citation	Setting and population	Study design and economic methods	Intervention and comparator conditions	Summary of findings
				of one-unit caloric gain, probability of net benefit is 18%)
Elia *et al.* [28], Data also reported in Parsons *et al.* [31]	• As per above	• As per above	• IG: Dietary advice for HPHE snacks and drinks with aid of a diet sheet. Saw dietitian at baseline and 6 weeks to receive advice about HPHE diet. Dietitian discussed plan with care home • CG: none. Compared to 12-week baseline observation period	• IG: quality of life (EQ-5D-TTO) decreased (μ change: −0.159) (not tested statistically). No change in body weight. kCal decreased (μ change: −93 kcal) (not tested statistically). QALY gained μ0.1128 ± 0.0086 • CG: N/A • Economic findings: direct cost of intervention: not reported Direct unit cost of health care utilisation: £186 ± 38. Significantly lower than ONS group (see above).
Lorefalt *et al.* [27]	• Sweden • Mean age 83–86 ± 8–9 years • N = 109 • Females = 50% • N = 6 aged care homes	• Non-randomised controlled trial • Intervention: 3 months • Follow-up: 3 months for clinical data, 1 year for cost data • Economic method: health care unit cost comparison on direct health care costs • Economic cost versus benefit/effect measured: cost = cost for each health care contact; benefit/effect = none included in economic analysis	• IG: aged care home staff provided with 3 × 2 h education programme by project leader—a nurse with nutrition background. MNA > 24 (well nourished) offered snack (e.g. fruit, yoghurt) at mid-meals. MNA < 24 (risk of malnutrition/ malnourished) had modified food choices within existing food availability and costs: offered appetiser at lunch (e.g. soup, egg, herring), additional snacks (e.g. smoothies, bread and butter, milk and yoghurt) distributed throughout the day according to needs and preference • CG: no change to routine meals	• IG: MN prevalence 26% at baseline and 12% at follow-up; body weight change at 3/12 follow-up 2.7 ± 3.9 kg; BMI at 3/12 follow-up 25.6 ± 4.9 kg/m^2 • CG: malnutrition prevalence 18% at baseline and 28% at follow-up; Body weight change at 3/12 follow-up -0.6 ± 4.9 kg; BMI at 3/12 follow-up 23.7 ± 4.9 kg/m^2 • Between groups: Body weight P = 0.0001; BMI P = 0.05 • Economic findings: direct health care cost in IG: median £924, CG: £847 per year. Not compared statistically
Odlund Olin *et al.* [26]	• Sweden • Median age 80–83 years (IQR: 71–89) • N = 40 • Female: 52% • N = 1 aged care home recruited (N = 2 clusters [wards])	• Non-randomised clustered controlled intervention trial • Intervention: 15 weeks • Follow-up: 29 weeks post-baseline/27 weeks post intervention commencement • Economic method: cost of Intervention. No analysis • Economic cost versus benefit/effect measured: cost = cost of additional butter and cream; benefit/effect = none included in economic analysis	• IG: served regular hospital diet fortified with butter and cream (2,100 kcal/day) • CG: served regular hospital diet (1,600 kcal/day)	• IG: compared with baseline, IG increased protein intake (median 48.3 [IQR: 41.8–54.3 g] versus median 57.9 [IQR: 46.2–61.2 g], P < 0.001). ADL remained unchanged • CG: worsened in ADL during the intervention (median score 15.5 [IQR: 10.0–17.0] increased to 16.0 [IQR: 15.0–18.0], P < 0.001) • Between groups: no difference for number of infections. IG increased energy intake (median 1,437 [IQR: 1,252–1,617 kcal] versus median 1,840 [IQR: 1,497–2,012 kcal], P < 0.01) • Economic findings: £0.10 per resident per day.

AT, afternoon tea; BMI, body mass index; CC, calf circumference; CEA, cost effectiveness analysis; CUA, cost utility analysis; CG, control group; IG, intervention group; kcal, kilocalorie; kg, kilogram; MAC, mid-arm circumference; ONS, oral nutrition supplements; RCT, randomised control trial; USD, United States Dollar.

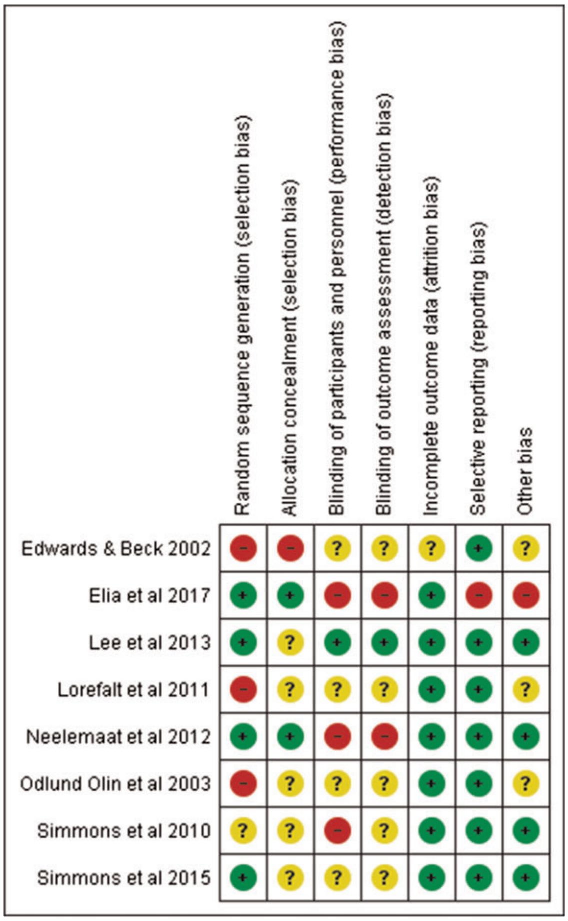

Figure 2. Risk of bias of included studies.

prevented synthesis or identification of a consistent finding across studies (Table 1).

The one environmental study reported a cost saving of $11.44 (assumed USD; £8.93) in decreased ONS use; however, this was measured in one third of the group only [25]. The quality of the evidence that the true financial effect of environmental interventions to improve nutrition was assessed as very low, downgraded due to uncertainty across most domains assessed by GRADE (Table 2).

Three of the studies which used an ONS intervention reported direct cost of the intervention, with a difference of USD$0.40 (£0.10) to USD$2.54 (£1.99) per resident per day between intervention and control groups [23, 24, 29]. Elia *et al.* [28] reported a direct cost of £162.30 per resident across 12 weeks (estimated as £1.93 per resident per day); but did not compare this with a control. Four ONS intervention studies also included cost-effectiveness analyses. The study by Neelemaat *et al.* [22] reveals that the study may be cost-effective in improving functional limitations (€618/functional limitation improvement) but not for improving QALYs (£24,798/QALY); but the cost is not reflective of savings only to aged care homes but rather to the health and aged care sector combined. The other two studies reported by Simmons *et al.* [23, 24] compare ONS with food-based interventions, with conflicting results; both interventions may be considered to have good probability of cost-efficacy (Table 1). The study by Elia *et al.* [28] reported £9857/QALY; however, this reflects the cost of ONS minus cost of the high protein-high energy group; and actual cost/QALY was not reported for either intervention. Certainty in the body of evidence that ONS is cost-effective to improve malnutrition in aged care homes was assessed as very low; primarily due to high risk of bias and heterogeneity across studies (Table 2).

Three of the five studies which used food-based interventions reported the direct cost of food-related interventions had a difference of £0.10 to USD$3.85 (£3.01) per resident per day [23, 24, 26]. Lorefalt *et al.* [30] also reported a difference between groups of direct cost of £77.26 per year; however, this included staff training as well as additional food items [27]. There was low confidence in the body of evidence that food-based interventions are cost-effective in aged care homes; due to a risk of bias and heterogeneity across studies (Table 2).

Clinical outcomes

Regarding clinical outcomes, two of the studies [21, 27] used the Mini Nutritional Assessment (MNA) in addition to other measures; however, most did not use validated malnutrition assessments [22–26] (Table 1). Body weight was reported in all of the studies [21–27, 31] and BMI in six. The next most reported outcomes were energy intake (n = 4 studies) and physical function (n = 3 studies). Some of the studies reported gender differences between malnutrition, however this was not listed in most of the studies.

All studies showed significant clinical improvement in the intervention groups; excepting the high protein-high energy advice group which was reported by Elia *et al.* [28] and also included in Parsons *et al.* [31] (results reported across two papers). Seven of the eight studies showed increases in weight and six interventions (reported in n = 4 studies) reported improvements in energy intake compared with control and/or baseline.

Discussion

There is good evidence that malnutrition places a significant financial burden on our health care system [5, 32, 33] as well as good evidence that supplements and other nutrition interventions improve intake and nutritional status [34, 35]. This review, however, revealed there is a lack of confidence in the body of economic evidence that introducing malnutrition interventions, whether they be environmental, supplements or food-based, are cost-effective in residential aged care. This lack of confidence is due to the small number and poor-quality of studies economically evaluating nutritional interventions in aged care; particularly for environmental interventions. Despite this, the review showed that included interventions had a low direct cost of implementation (less than £2.30 per resident per day) and provided clinical improvement in patients. Supplements and

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Table 2. GRADE assessment of the cost-effectiveness environmental, oral nutrition support or food-based malnutrition interventions

Outcome: Cost-effectiveness (assessed with: direct cost, cost utility analysis or cost effectiveness analysis)

Quality assessment							Number of patients		Quality	Importance
Number of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations (e.g. publication bias, large effect, plausible confounding and dose response gradient)	Intervention group	Control group (no intervention)		
Question: Environmental changes compared to any other method of nutrition intervention or provision for cost-effectively preventing and/or managing malnutrition in residential aged care										
1	Randomised trials[a]	Very serious[b]	Very serious[c]	Very serious[d]	Very serious[e]	None	45	17	⊕○○○ Very low	Important
Question: Supplements compared to usual are for cost-effectively preventing and/or managing malnutrition in residential aged care										
4	Randomised trials	Very serious[b]	Serious[f]	Not serious	Not serious	None	275	218	⊕○○○ Very low	Important
Question: Food modifications compared to any other method of nutrition intervention or provision for cost-effectively preventing and/or managing malnutrition in residential aged care										
5	Randomised and non-randomised controlled trials[g]	Serious[b]	Serious[h]	Not serious	Not serious	None	292	258	⊕⊕○○ Low	Important

[a]Cluster non-randomised controlled trial.
[b]Risk of bias assessed by the Cochrane risk of bias tool (Figure 2).
[c]Data relating to cost outcomes were reported for only one of the groups. No data provided for consistency within study groups (three groups received intervention in cross-over design). Could not be compared to any other studies.
[d]Cost-saving data was reported for the decreased spend of supplements; which is not a direct measure of the environmental intervention. There is no confidence that the cost-related outcome is due to the intervention.
[e]No measure of variability reported.
[f]Some inconsistency between the two most clinically homogenous studies (Simmons *et al.* [23, 24]). Combined studies all show cost of ONS is low and results in clinical benefit.
[g]Three studies were non-randomised controlled trials; two were RCTs.
[h]Interventions included significant clinical heterogeneity; however, cost-related results were reported differently between studies making comparison of consistency difficult.

food-based interventions further demonstrated a low cost per QALY or unit of physical function improvement.

There is great variation in the scope of economic reviews on the topic of malnutrition. One large nutrition and health economics review looked at malnutrition across all ages and settings and concluded nutrition to be a powerful force improving both the health and economic status of society [16]. However, in agreement with the current review, the study found large variations in the approach to economic modelling of malnutrition interventions, and highlighted the need for a well-defined framework for economic analysis on nutrition interventions [16].

Although this current review found insufficient evidence supporting the cost-effectiveness of malnutrition interventions in aged care homes, evidence in the acute setting is stronger as evaluated by three recent systematic reviews [13, 35, 36]. Mitchell *et al.* [13] in a systematic review concluded that malnutrition interventions in the hospital setting showed positive cost-effectiveness for improving outcomes, informed by intervention studies from 2003 to 2013. Although Mitchell *et al.* only identified three studies for inclusion, they were comprehensive and of a high quality. In 2017, the systematic review by Muscaratoli *et al.* [36] found that there was insufficient evidence as to whether supplements significantly reduced hospital readmissions when given to malnourished hospitalised patients and outpatients. However, Muscaratoli [36] found supplements resulted in cost savings with a return of investment of $52.63 in net savings for every dollar spend on supplements in terms of reduced episode cost amongst young patients. The systematic review by Elia *et al.* [35] also examined the cost-effectiveness of using supplements in hospitals, and subgroup analysis found supplements to be cost-effective with a mean net cost saving of £746 per patient. In this same review, the mean cost saving across 12 of the 14 cost analysis studies comparing supplements with routine care found 12.2% mean cost saving with supplements use [35]. Further hospital-based economic modelling by Banks *et al.* [37] showed cost-effective reduction in risk of developing pressure ulcers with the use of nutritional intervention (including costs of additional food, supplements and additional nutrition/nursing support staff time). This strong and consistent evidence in support of nutrition interventions to cost-effectively improve malnutrition in the acute care setting suggests that similar conclusions may be found in the aged care setting once further well-conducted studies including economic data are undertaken.

Limitations and implications for future research

This systematic literature review focussed on interventional studies only, as these studies provide a higher quality of evidence to evaluate the research question. However, it is acknowledged that excluding observational studies may limit potential learnings [38], particularly regarding external validity. All but two included studies did not sufficiently evaluate the impact of interventions on malnutrition, and none used malnutrition in the cost-utility analysis. Instead,

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the outcomes of weight, BMI, energy intake and physical function were most frequently used. Although these are important components of malnutrition assessment, they do not reflect malnutrition risk or status alone.

Future research on cost-effectiveness of nutrition-related interventions in the aged care setting need to accurately measure malnutrition, clearly describe interventions and economic methods and provide a detailed description of research design. Rigorous intervention and economic study designs, such as RCTs and cost-utility analyses in future malnutrition studies in the aged care setting may further strengthen and increase confidence in the cost-effective treatment of malnutrition. Although research has demonstrated nutrition interventions are low risk and effective in improving clinical outcomes, stronger evidence regarding cost-effectiveness will support aged care funders and governance to select the most cost-effective treatment options.

Conclusion interventions

Malnutrition places significant economic burden upon the aged care sector and nutrition may be a powerful force for improving both the health and economic status of aged care homes. While there is good evidence that nutrition improves clinical outcomes, the limited and poor-quality studies including economic data in this review indicate evidence of cost-effectiveness in the aged care setting is still limited. This systematic review suggests that supplements and food-based nutrition interventions in the aged care setting have a low cost of implementation, low risk of harm, and may be cost-effective. More studies using well-defined frameworks for economic analysis, stronger study designs such as double-blinded RCTs, improved quality (reduced risk of bias), along with validated malnutrition measures are needed.

Key points

- Malnutrition is a significant economic burden on society.
- Nutrition offers opportunity to improve the quality of life of residents and the economic position of aged care homes.
- Quality economic studies evaluating malnutrition interventions in the aged care setting are lacking.
- More robust malnutrition economic evaluation intervention studies in aged care are needed to support research translation.

Supplementary data

Supplementary data mentioned in the text are available to subscribers in *Age and Ageing* online.

Conflict of interest

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References

1. Milte RK, Ratcliffe J, Miller MD, Crotty M. Economic evaluation for protein and energy supplementation in adults: opportunities to strengthen the evidence. Eur J Clin Nutr 2013; 67: 1243–50.
2. Commission, P. *Economic implications of an ageing Australia*. Productivity Commission, Government of Australia Research Reports, 2005.
3. Ratcliffe J, Laver K, Couzner L, Crotty M. Health economics and geriatrics: challenges and opportunities. In: Geriatrics, InTech 2012.
4. Marshall S. Protein-energy malnutrition in the rehabilitation setting: evidence to improve identification. Maturitas 2016; 86: 77–85.
5. Meijers JMM, Halfens R, Wilson L, Schols J. Estimating the costs associated with malnutrition in Dutch nursing homes. Clin Nutr 2012; 31: 65–8.
6. Freijer K, Tan SS, Koopmanschap MA *et al*. The economic costs of disease related malnutrition. Clin Nutr 2013; 32: 136–41.
7. Russell CA. The impact of malnutrition on healthcare costs and economic considerations for the use of oral nutritional supplements. Clin Nutr Suppl 2007; 2: 25–32.
8. Rice N, Normand C. The cost associated with disease-related malnutrition in Ireland. Public Health Nutr 2012; 15: 1966–72.
9. Strathmann S, Lesser S, Bai-Habelski J *et al*. Institutional factors associated with the nutritional status of residents from 10 German nursing homes (ErnSTES study). J Nutr Health Aging 2013; 17: 271–6.
10. Hugo C, Isenring E, Sinclair D, Agarwal E. What does it cost to feed aged care residents in Australia? Nutr Diet 2017.
11. Agarwal E, Marshall S, Miller M, Isenring E. Optimising nutrition in residential aged care: a narrative review. Maturitas 2016; 92: 70–8.
12. Cost saving guidance, 2016. National Institute for Health and Clinical Excellence (NICE). Available at https://www.nice.org.uk/about/what-we-do/into-practice/cost-saving-guidance (11 December 2017, date last accessed).
13. Mitchell H, Porter J. The cost-effectiveness of identifying and treating malnutrition in hospitals: a systematic review. J Hum Nutr Diet 2016; 29: 156–64.
14. Weekes CE, Spiro A, Baldwin C *et al*. A review of the evidence for the impact of improving nutritional care on nutritional and clinical outcomes and cost. J Hum Nutr Diet 2009; 22: 324–35.
15. Walzer S, Droeschel D, Nuijten M, Chevrou-Séverac H. Health economics evidence for medical nutrition: are these interventions value for money in integrated care? Clinicoecon Outcomes Res 2014; 6: 241–52.
16. Gyles CL, Lenoir-Wijnkoop I, Carlberg JG *et al*. Health economics and nutrition: a review of published evidence. Nutr Rev 2012; 70: 693–708.
17. Liberati A, Altman DG, Tetzlaff J *et al*. The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate healthcare interventions: explanation and elaboration. Br Med J 2009; 339: b2700–00.

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18. Welfare, A.I.o.H.a. *25 Years of health expenditure in Australia 1989–90 to 2013–14*. 2015 (Health and Welfare Expenditure Series No. 56).
19. Oxford, U.o. Critical Appraisal Tools—Centre for Evidence-Based Medicine. Website.
20. Guyatt GH, Oxman AD, Vist GE *et al*. GRADE: an emerging consensus on rating quality of evidence and strength of recommendations. Br Med J 2008; 336: 924–6.
21. Lee LC, Tsai AC, Wang JY, Hurng BS, Hsu HC, Tsai HJ. Need-based intervention is an effective strategy for improving the nutritional status of older people living in a nursing home: a randomized controlled trial. Int J Nurs Stud 2013; 50: 1580–8.
22. Neelemaat F, Bosmans JE, Thijs A, Seidell JC, van Bokhorst-de van der Schueren MA. Oral nutritional support in malnourished elderly decreases functional limitations with no extra costs. Clin Nutr 2012; 31: 183–90.
23. Simmons SF, Zhuo X, Keeler X. Cost- effectiveness of nutrition interventions in nursing home residents: a pilot intervention. J Nutr Health Aging 2010; 14: 367–72.
24. Simmons SF, Keeler E, An R *et al*. Cost-effectiveness of nutrition intervention in long-term care. J Am Geriatr Soc 2015; 63: 2308–16.
25. Edwards NE, Beck AM. Animal-assisted therapy and nutrition in Alzheimer's disease. West J Nurs Res 2002; 24: 697–712.
26. Odlund Olin A, Armyr I, Soop M *et al*. Energy-dense meals improve energy intake in elderly residents in a nursing home. Clin Nutr 2003; 22: 125–31.
27. Lorefält B, Andersson A, Wirehn AB, Wilhelmsson S. Nutritional status and health care costs for the elderly living in municipal residential homes—an intervention study. J Nutr Health Aging 2011; 15: 92–7.
28. Elia M, Parsons EL, Cawood AL, Smith TR, Stratton RJ. Cost-effectiveness of oral nutritional supplements in older malnourished care home residents. Clin Nutr 2017.
29. Lee LC, Tsai AC, Wang JY, Hurng BS, Hsu HC, Tsai HJ. Need-based intervention is an effective strategy for improving the nutritional status of older people living in a nursing home: a randomized controlled trial. Int J Nurs Stud 2013; 50: 1580–8.
30. Lorefält B, Andersson A, Wirehn AB, Wilhelmsson S. Nutritional status and health care costs for the elderly living in municipal residential homes—an intervention study. J Nutr Health Aging 2011; 15: 92–7.
31. Parsons EL, Stratton RJ, Cawood AL, Smith TR, Elia M. Oral nutritional supplements in a randomised trial are more effective than dietary advice at improving quality of life in malnourished care home residents. Clin Nutr 2017; 36: 134–42.
32. Elia M, The cost of malnutrition in England and potential cost savings from nutritional interventions (full report). BAPEN report, 2015.
33. Snider JT, Linthicum MT, Wu Y *et al*. Economic burden of community-based disease-associated malnutrition in the United States. J Parenter Enteral Nutr 2014; 38(2 Suppl): 77S–85S.
34. Baldwin C, Kimber KL, Gibbs M, Weekes CE. Supportive interventions for enhancing dietary intake in malnourished or nutritionally at-risk adults. Cochrane Database Syst Rev 2016; 12: 009840.
35. Elia M, Normand C, Norman K, Laviano A. A systematic review of the cost and cost effectiveness of using standard oral nutritional supplements in the hospital setting. Clin Nutr 2016; 35: 370–80.
36. Muscaritoli M, Krznarić Z, Singer P *et al*. Effectiveness and efficacy of nutritional therapy: a systematic review following Cochrane methodology. Clin Nutr 2017; 36: 939–57.
37. Banks MD, Graves N, Bauer JD, Ash S. Cost effectiveness of nutrition support in the prevention of pressure ulcer in hospitals. Eur J Clin Nutr 2013; 67: 42–6.
38. Kovesdy CP, Kalantar-Zadeh K. Observational studies versus randomized controlled trials: avenues to causal inference in nephrology. Adv Chronic Kidney Dis 2012; 19: 11–8.

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